CLAIMS

What is claimed is:

1. A system for estimating a range of at least one object in an environment, comprising:

a transmitter configured to transmit at least one first signal through a predetermined transmission medium within the environment, the first signal having a predetermined frequency range and an associated center frequency, wherein the first signal travels through the transmission medium until it strikes at least one object, thereby generating at least one second signal reflected from the object; and

a sub-system including a cross correlator, the cross correlator being operative to receive representations of the first and second signals, and to perform at least one cross correlation operation on the first and second signals to detect at least one cross correlation peak, the sub-system being operative to estimate the range of the object based on the detected cross correlation peak,

wherein the sub-system is further operative to estimate a signal-to-noise ratio (SNR) in the environment, the SNR being at least partially dependent upon the frequency associated with the first signal, and to control the transmitter to dynamically change at least the frequency associated with the first signal based on the estimated SNR.

2. The system of claim 1 wherein the sub-system further includes

a plurality of band-pass filters, each band-pass filter being configured to pass a respective sub-band of frequencies, each band-pass filter being further configured to receive the representations of the first and second

signals, to filter the representations of the first and second signals, and to provide filtered versions of the first and second signals;

the cross correlator being further configured to receive the filtered versions of the first and second signals provided by the respective band-pass filters, and to perform multiple cross correlation operations on the filtered first and second signals, thereby providing cross correlation output data,

wherein each cross correlation operation operates on the filtered first and second signals provided by a respective one of the band-pass filters; and

a data analyzer configured to receive the cross correlation output data, and to analyze the output data for determining variability of cross correlation peaks within each frequency sub-band, for identifying the lowest frequency sub-band having a corresponding low peak ambiguity, and for estimating the SNR in the environment based on the peak variability and center frequency of the identified frequency sub-band and the predetermined frequency range.

3. The system of claim 2 further including a sensor configured to receive the at least one second signal.

4. The system of claim 3 wherein the sensor comprises at least one hydrophone sensor.

5. The system of claim 3 further including a receiver configured to receive an indication of the second signal from the sensor, and to provide the representation of the second signal to the sub-system.

6. The system of claim 2 wherein the transmitter is configured to transmit a plurality of first signals through the transmission medium, each first signal having the predetermined frequency range, wherein the plurality of first signals travel through the transmission medium until they strike at least one object, thereby generating a plurality of second signals reflected from the object.

7. The system of claim 6 wherein the data analyzer is further configured to analyze the cross correlation output data for determining a plurality of cross correlation peak locations relative to respective ambiguity functions corresponding to the frequency sub-bands.

8. The system of claim 7 wherein the data analyzer is further configured to perform a statistical analysis on the plurality of peak locations for determining the variability of cross correlation peaks within each frequency sub-band.

9. The system of claim 6 wherein each first signal comprises a sonar ping.

10. The system of claim 2 wherein the respective frequency sub-bands are contiguous and substantially span the predetermined frequency range of the first signal.

11. The system of claim 2 wherein the system operates as a coherent receiver for signal frequencies ranging from a maximum frequency through the identified frequency sub-band.

12. The system of claim 2 wherein the system operates as a semi-coherent receiver for signal frequencies ranging from the identified frequency sub-band to a minimum frequency.

13. The system of claim 1 wherein the predetermined frequency range is a maximum centralized root mean square bandwidth of the first signal.

14. The system of claim 1 wherein the predetermined transmission medium is one of air, water, soil, and living tissue.

15. A method of estimating a range of at least one object in an environment, comprising the steps of:

transmitting at least one first signal through a predetermined transmission medium within the environment by a transmitter, the first signal having a predetermined frequency range and an associated center frequency, wherein the first signal travels through the transmission medium until it strikes at least one object, thereby generating at least one second signal reflected from the object;

receiving representations of the first and second signals by a cross correlator;

performing at least one cross correlation operation on the first and second signals to detect at least one cross correlation peak by the cross correlator;

estimating the range of the object based on the detected cross correlation peak;

estimating a signal-to-noise ratio (SNR) in the environment, the SNR being at least partially dependent upon the frequency associated with the first signal; and

controlling the transmitter for dynamically changing at least the frequency associated with the first signal based on the estimated SNR.

16. The method of claim 15 further including the steps of:

receiving the representations of the first and second signals by a plurality of band-pass filters, each band-pass filter being configured to pass a respective sub-band of frequencies;

filtering the representations of the first and second signals by each band-pass filter;

receiving the filtered versions of the first and second signals by the cross correlator;

performing multiple cross correlation operations on the filtered first and second signals by the cross correlator, thereby providing cross correlation output data, wherein each cross correlation operation operates on the filtered first and second signals provided by a respective one of the band-pass filters;

receiving the cross correlation output data by a data analyzer;

determining variability of cross correlation peaks within each frequency sub-band by the data analyzer; and

identifying the lowest frequency sub-band having a corresponding low peak ambiguity by the data analyzer,

wherein the SNR estimating step includes estimating the SNR based on the peak variability and center frequency of the identified frequency sub-band and the predetermined frequency range by the data analyzer.

17. The method of claim 16 further including the step of receiving the at least one second signal by a sensor.

18. The method of claim 17 wherein the sensor comprises at least one hydrophone sensor.

19. The method of claim 17 further including the steps of receiving an indication of the second signal from the sensor by a receiver, and providing the representation of the second signal to the plurality of band-pass filters by the receiver.

20. The method of claim 16 wherein the transmitting step includes transmitting a plurality of first signals through the transmission medium by the transmitter, each first signal having the predetermined frequency range, wherein the plurality of first signals travel through the transmission medium until they strike at least one object, thereby generating a plurality of second signals reflected from the object.

21. The method of claim 20 further including the step of analyzing the cross correlation output data by the data analyzer for determining a plurality of cross correlation peak locations relative to respective ambiguity functions corresponding to the frequency sub-bands.

22. The method of claim 21 further including the step of performing a statistical analysis of the plurality of peak locations by the data analyzer for determining the variability of cross correlation peaks within each frequency sub-band.

23. The method of claim 20 wherein each first signal comprises a sonar ping.

24. The method of claim 18 wherein the respective frequency sub-bands are contiguous and substantially span the predetermined frequency range of the first signal.

25. The method of claim 16 further including the step of operating as a coherent receiver for signal frequencies ranging from a maximum frequency through the identified frequency sub-band.

26. The method of claim 16 further including the step of operating as a semi-coherent receiver for signal frequencies ranging from the identified frequency sub-band to a minimum frequency.

27. The method of claim 15 wherein the predetermined frequency range is a maximum centralized root mean square bandwidth of the first signal.

28. The method of claim 15 wherein the predetermined transmission medium is one of air, water, soil, and living tissue.

29. A system for estimating a range of at least one object in an environment, comprising:

a transmitter configured to transmit at least one first signal through a predetermined transmission medium within the environment, the first signal having a predetermined frequency range and an associated center frequency, wherein the first signal travels through the transmission medium

until it strikes at least one object, thereby generating at least one second signal reflected from the object; and

a sub-system including a cross correlator, the cross correlator being operative to receive representations of the first and second signals, and to perform at least one cross correlation operation on the first and second signals to detect at least one cross correlation peak, the sub-system being operative to estimate the range of the object based on the detected cross correlation peak,

wherein the sub-system is further operative to control the transmitter to dynamically change at least the frequency associated with the first signal based on a predetermined signal-to-noise ratio (SNR) in the environment.

30. A method of estimating a range of at least one object in an environment, comprising the steps of:

transmitting at least one first signal through a predetermined transmission medium within the environment by a transmitter, the first signal having a predetermined frequency range and an associated center frequency, wherein the first signal travels through the transmission medium until it strikes at least one object, thereby generating at least one second signal reflected from the object;

receiving representations of the first and second signals by a cross correlator;

performing at least one cross correlation operation on the first and second signals to detect at least one cross correlation peak by the cross correlator; and

estimating the range of the object based on the detected cross correlation peak,

wherein the transmitting step includes controlling the transmitter to dynamically change at least the frequency

associated with the first signal based on a predetermined signal-to-noise ratio (SNR) in the environment.